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(54) NONAQUEOUS ELECTROLYTE SECONDARY BATTERY**(57)Abstract:**

PROBLEM TO BE SOLVED: To provide a nonaqueous electrolyte secondary battery using, as a main solvent, nonaqueous solution having a relatively higher flash point and larger than 25 for relative permittivity, thereby improving the battery characteristics.

SOLUTION: In a nonaqueous electrolyte secondary battery comprising a negative electrode, a positive electrode, a solute and a nonaqueous solvent, where the nonaqueous solvent contains more than 90 wt.% of one or two nonaqueous solvents selected from solvents having relative permittivity larger than 25 and a flash point of higher than 70°C and further contains at least one of vinyl ethylene carbonates.

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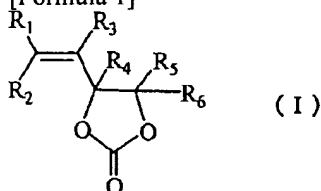
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CLAIMS

[Claim(s)]

[Claim 1] A nonaqueous electrolyte rechargeable battery characterized by adding at least one sort in vinyl ethylene carbonate which one sort or two sorts or more of solvents with which a non-aqueous solvent is chosen from a with a specific inductive capacity of 25 or more solvent are contained 90% of the weight or more in a nonaqueous electrolyte rechargeable battery equipped with a nonaqueous electrolyte which consists of a negative electrode, a positive electrode, and a solute and a non-aqueous solvent at least, and the flash point of this non-aqueous solvent is 70 degrees C or more, and is further expressed with the following general formula (I) to this non-aqueous solvent.

[Formula 1]



(The inside R1 of a formula, R2, R3, R4, R5, and R6 express independently a hydrogen atom or the alkyl group of carbon numbers 1-4, respectively.)

[Claim 2] A nonaqueous electrolyte rechargeable battery according to claim 1 characterized by adding at least one sort of vinyl ethylene carbonate as which a non-aqueous solvent is expressed in said general formula (I) by with a specific inductive capacity of 25 or more solvent.

[Claim 3] A nonaqueous electrolyte rechargeable battery according to claim 1 or 2 characterized by an amount of vinyl ethylene carbonate expressed with said general formula (I) added being 0.01 - 10% of the weight expressed with this non-aqueous solvent and this general formula (I) of the total quantity of vinyl ethylene carbonate.

[Claim 4] A nonaqueous electrolyte rechargeable battery according to claim 1 to 3 with which a with a non-dielectric constants of 25 or more solvent is characterized by being ethylene carbonate, propylene carbonate, butylene carbonate, gamma-butyrolactone, and gamma-valerolactone.

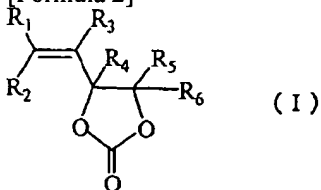
[Claim 5] A nonaqueous electrolyte rechargeable battery according to claim 1 to 4 with which a negative electrode is characterized by containing occlusion and a carbonaceous object which can be emitted for a lithium.

[Claim 6] A nonaqueous electrolyte rechargeable battery according to claim 1 to 5 characterized by negative electrodes being one or more sorts chosen [lithium / occlusion, a carbonaceous object which can be emitted or this carbonaceous object, a lithium, a lithium alloy, and] from a group which consists of occlusion and a metallic oxide which can be emitted in a lithium of mixture.

[Claim 7] A nonaqueous electrolyte rechargeable battery according to claim 5 or 6 characterized by a carbonaceous object being the graphite whose d value of a lattice plane (002nd page) in an X diffraction is 0.335-0.340nm.

[Claim 8] It is the nonaqueous electrolyte for nonaqueous electrolyte rechargeable batteries equipped with occlusion, and a negative electrode and a positive electrode which can be emitted for a lithium at least. This nonaqueous electrolyte consists of a solute and a non-aqueous solvent, and one sort or two sorts or more of solvents with which this non-aqueous solvent is chosen from a with a specific inductive capacity of 25 or more solvent are contained 90% of the weight or more. And said nonaqueous electrolyte characterized by adding at least one sort in vinyl ethylene carbonate which the flash point of this non-aqueous solvent is 70 degrees C or more, and is further expressed with the following general formula (I) to this non-aqueous solvent.

[Formula 2]



(The inside R1 of a formula, R2, R3, R4, R5, and R6 express independently a hydrogen atom or the alkyl group of carbon numbers 1-4, respectively.)

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the nonaqueous electrolyte used for a nonaqueous electrolyte rechargeable battery and it. It is related with amelioration of the nonaqueous electrolyte rechargeable battery which uses in detail the electrolytic solution which added the vinyl ethylene carbonate of specific structure for a specific non-aqueous solvent. According to this invention, in the rechargeable battery which used the non-aqueous solvent of high specific inductive capacity, charge-and-discharge effectiveness is highly excellent in a cycle property, and offer of a rechargeable battery with high safety of it is attained.

[0002]

[Description of the Prior Art] The need of a lithium secondary battery with high energy density has been increasing with lightweight-izing of an electric product in recent years, and a miniaturization. Furthermore, much more improvement in a cell property is also demanded with expansion of Field of application of a lithium secondary battery. It had become a technical problem technical [of the max in which it obstructs utilization that a short circuit arises / in / although research is done briskly / for many years / as a cell by which the rechargeable battery which uses a former and metal lithium as a negative electrode can attain high capacity-ization, a metal lithium grows up to be the shape of a dendrite by the repeat of charge and discharge, and finally reach a positive electrode, and / the interior of a cell].

[0003] To this, the nonaqueous electrolyte rechargeable battery which used occlusion and the carbonaceous material which can be emitted is proposed in lithiums, such as corks, an artificial graphite, and a natural graphite, by the negative electrode. In such a nonaqueous electrolyte rechargeable battery, since a lithium does not exist in the state of a metal, formation of a dendrite is controlled, and a battery life and safety can be improved. Especially the nonaqueous electrolyte rechargeable battery using graphite system carbonaceous materials, such as an artificial graphite and a natural graphite, attracts attention as what meets the demand of high-capacity-izing.

[0004] In the lithium secondary battery which uses the above-mentioned carbonaceous material, annular carbonate, such as propylene carbonate and ethylene carbonate, is usually widely used as a high dielectric constant solvent of nonaqueous electrolyte. In the nonaqueous electrolyte rechargeable battery using non-graphite system carbonaceous materials, such as corks, the solvent containing propylene carbonate can use suitably. On the other hand, in the nonaqueous electrolyte rechargeable battery which is independent, or mixed the graphite system carbonaceous material with other negative-electrode material which can emit [occlusion and] a lithium, and was used as the negative electrode, if the solvent containing propylene carbonate is used, the decomposition reaction of propylene carbonate will advance violently in an electrode surface at the time of charge, and the occlusion and emission of the smooth lithium to a graphite electrode will become impossible.

[0005] On the other hand, it cannot be said that ethylene carbonate is enough about problems, such as a fall of the cycle property by disassembly of the electrolytic solution, although ethylene carbonate is used abundantly as a high dielectric constant solvent in the electrolytic solution of the nonaqueous electrolyte rechargeable battery using a graphite system negative electrode since there is little such decomposition. Furthermore, compared with propylene carbonate, since the congealing point is as high as 36.4 degrees C, ethylene carbonate is not used independently, and generally it mixes with a hypoviscosity solvent and it is used. If a hypoviscosity solvent generally adds in large quantities since the boiling point is also low in many cases although the mixed solvent of ethylene carbonate and diethyl carbonate etc. is usually used for the electrolytic solution for lithium secondary batteries using a graphite system negative electrode for such a reason, although it is good in respect of the engine performance of the electrolytic solution, there is a problem to which the flash point of a solvent falls, and if little deer addition is not carried out, a problem is in reverse in respect of the conductivity in low temperature, and viscosity.

[0006] In such a condition, a lithium and the compound which has the carbon-carbon bonding of the partial saturation which cannot react easily in a chain type, for example, the electrolytic solution using vinyl ethylene carbonate, are proposed by JP 4-87156 A as a solvent in the nonaqueous electrolyte cell which used the lithium metal for the negative electrode. However, since mixed use is carried out with 1 and 2-dimethoxyethane which is the low-boiling point solvent of *****, vinyl ethylene carbonate does not cancel an above-mentioned technical problem.

[0007] Its congealing point is also low while the gamma-butyrolactone which is cyclic ester on the other hand has high specific inductive capacity, although using without mixing a hypoviscosity solvent is possible, the decomposition reaction of gamma-butyrolactone advances on the graphite-electrode surface at the time of charge, and the aggravation of the property as a cell also of the electrolytic solution of a gamma-butyrolactone system is a problem. In order to suppress decomposition of

the gamma-butyrolactone in the nonaqueous electrolyte rechargeable battery which used the graphite system carbon material for the negative electrode, gamma-butyrolactone is used as a principal component and the solvent of the electrolytic solution which is the presentation which contains diethyl carbonate more than 16 capacity % still more practical is proposed by JP, 11-31525, A including the ethylene carbonate of a 15 - 35 capacity % degree as an accessory constituent.

[0008]

[Problem(s) to be Solved by the Invention] However, the further amelioration is desired although the effect that the electrolytic solution proposed as well-known technology is appropriate is seen. This invention makes a technical problem comparatively high offer of the nonaqueous electrolyte rechargeable battery which can demonstrate a good cell property when the specific inductive capacity of the flash point uses 25 or more nonaqueous solvents as a main solvent.

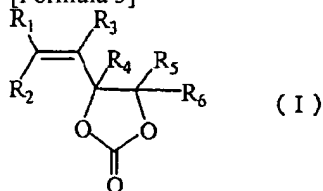
[0009]

[Means for Solving the Problem] As a result of inquiring wholeheartedly in view of this situation, this invention person etc. as a solvent of the electrolytic solution of a nonaqueous electrolyte rechargeable battery One sort or two sorts or more of solvents with which specific inductive capacity is chosen from 25 or more solvents are contained 90% of the weight or more. And when at least one sort of flash points use a vinyl ethylene carbonate compound which has further specific structure for a non-aqueous solvent which is 70 degrees C or more, adding to it Charge-and-discharge effectiveness finds out that it can excel in a cycle property highly and safety can also be raised, and it came to complete this invention.

[0010] Namely, this invention is set to a nonaqueous electrolyte rechargeable battery equipped with a nonaqueous electrolyte which consists of a negative electrode, a positive electrode, and a solute and a non-aqueous solvent at least. One sort or two sorts or more of solvents chosen from a with an inductivity of 25 or more solvent are contained 90% of the weight or more. a non-aqueous solvent -- a ratio -- And the flash point of this non-aqueous solvent is 70 degrees C or more, and it is in a nonaqueous electrolyte rechargeable battery characterized by adding at least one sort in vinyl ethylene carbonate further expressed with the following general formula (I) to this non-aqueous solvent, and a nonaqueous electrolyte which uses it.

[0011]

[Formula 3]



[0012] (The inside R1 of a formula, R2, R3, R4, R5, and R6 express independently a hydrogen atom or the alkyl group of carbon numbers 1-4, respectively.)

In addition, as for the non-aqueous solvent used for the rechargeable battery of this invention, it is desirable that at least one sort of vinyl ethylene carbonate expressed with said general formula (I) by one sort or two sorts or more of solvents chosen from a with a specific inductive capacity of 25 or more solvent is added.

[0013] Moreover, as for the amount of the vinyl ethylene carbonate expressed with said general formula (I) added, it is desirable that it is 0.01 - 10 % of the weight based on the total quantity of the vinyl ethylene carbonate expressed with this non-aqueous solvent and this general formula (I). Furthermore, as for the negative electrode used for the rechargeable battery of this invention, what contains occlusion and the carbonaceous object which can be emitted for a lithium is desirable.

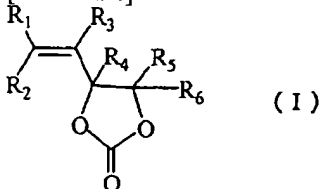
[0014]

[Embodiment of the Invention] In the nonaqueous electrolyte rechargeable battery equipped with the nonaqueous electrolyte which consists of a negative electrode, a positive electrode, and a solute and a non-aqueous solvent, a non-aqueous solvent contains one sort or two sorts or more of solvents with which specific inductive capacity is chosen from 25 or more solvents 90% of the weight or more, and the flash point of this non-aqueous solvent is 70 degrees C or more, and the nonaqueous electrolyte rechargeable battery of this invention is characterized by adding at least one sort of vinyl ethylene carbonate further expressed with said general formula (I).

[0015] Although the specific inductive capacity used for this invention is not limited especially as 25 or more non-aqueous solvents, ethylene carbonate, propylene carbonate, butylene carbonate, gamma-butyrolactone, gamma-valerolactone, a sulfolane, 3-methyl sulfolane, dimethyl sulfoxide, etc. are mentioned, and ethylene carbonate, propylene carbonate, gamma-butyrolactone, and gamma-valerolactone are desirable especially. Two or more sorts may be mixed, these solvents may be used, and especially combination is not restricted. The vinyl ethylene carbonate expressed with the following general formula (I) is added by the non-aqueous solvent used by this invention.

[0016]

[Formula 4]



[0017] It sets at a ceremony (I) and is R1, R2, R3, R4, and R5. And R6 A hydrogen atom or the alkyl group of carbon numbers 1-4 is expressed independently, respectively. R1, R2, R3, and R4 and R5 And R6 When it is the alkyl group of carbon numbers 1-4, as the example, a methyl group, an ethyl group, n-propyl group, i-propyl group, n-butyl, sec-butyl, and tert-butyl are mentioned. A methyl group and an ethyl group are desirable in these.

[0018] and as an example of a vinyl ethylene carbonate compound expressed with such a general formula (I) 4-ethenyl -1, 3-dioxolane-2-ON (vinyl ethylene carbonate), The 4-ethenyl-4-methyl -1, 3-dioxolane-2-ON, 4-ethenyl-4-ethyl -1, 3-dioxolane-2-ON, The 4-ethenyl-4-n-propyl -1, 3-dioxolane-2-ON, The 4-ethenyl-5-methyl -1, 3-dioxolane-2-ON, 4-ethenyl-5-ethyl -1, 3-dioxolane-2-ON, the 4-ethenyl-5-n-propyl -1, 3-dioxolane-2-ON, etc. can be mentioned.

[0019] Especially, vinyl ethylene carbonate, the 4-ethenyl-4-methyl -1, and 3-dioxolane-2-ON are desirable, and especially vinyl ethylene carbonate is desirable. Two or more sorts may be mixed and these may be used. Preferably, based on the total quantity of the vinyl ethylene carbonate expressed with the above-mentioned non-aqueous solvent and a general formula (I), it is 0.01 - 10 % of the weight, and still more preferably, the addition of the vinyl ethylene carbonate expressed with the general formula (I) used by this invention is 0.1 - 10 % of the weight, and its 0.5 - 7 % of the weight is especially desirable.

[0020] In the non-aqueous solvent used by this invention, 25 or more solvents contain [the above-mentioned specific inductive capacity] 90% of the weight or more. In this invention, that by which the vinyl ethylene carbonate as which the above-mentioned specific inductive capacity is expressed in the above-mentioned general formula (I) for a non-aqueous solvent by 25 or more solvents is added is desirable. Moreover, in this invention, the above-mentioned specific inductive capacity can add [a non-aqueous solvent] one or more sorts of chain-like ester, such as the chain-like ether, such as cyclic ether, such as dialkyl (thing of carbon numbers 1-4 is desirable) carbonate, such as non-aqueous solvents other than the above, for example, dimethyl carbonate, diethyl carbonate, G n-propyl carbonate, and ethyl methyl carbonate, a tetrahydrofuran, and 2-methyl tetrahydrofuran, dimethoxyethane, and dimethoxymethane, methyl acetate, and ethyl propionate, etc. to 25 or more solvents. In this case, it can add in the combination of the range where the flash point of the non-aqueous solvent containing the added solvent becomes 70 degrees C or more, and a solvent.

[0021] Lithium salt is used for the electrolytic solution used by this invention as a solute. If the lithium salt which can be used can be used as a solute of the electrolytic solution, especially the class will not be restricted. for example, LiClO₄, LiPF₆, and LiBF₄ from -- inorganic lithium salt and LiCF₃ SO₃ which are chosen, LiN (CF₃ SO₂)₂, LiN (CF₃ CF₂ SO₂)₂, LiN (CF₃ SO₂) (C₄ F₉ SO₂), and Li(CF₃ SO₂)₃ etc. -- fluorine-containing organic lithium salt can be used. They are LiPF₆ and LiBF₄ especially. Using is desirable. Two or more kinds may be mixed and these lithium salt may be used.

[0022] As for the lithium salt mol concentration of the solute in the electrolytic solution, it is desirable that it is 0.5-2.0 mols/l. When l. is exceeded in less than 0.5 mols [l.] /or 2.0 mols /, the conductivity of the electrolytic solution becomes low and it is in the orientation for the engine performance of a cell to fall. As a material of the negative electrode which constitutes the cell of this invention, what contains occlusion and the carbonaceous object which may be emitted for a lithium is desirable. As an example of this carbonaceous object, the pyrolysis object of the organic substance in various pyrolysis conditions, an artificial graphite, a natural graphite, etc. are mentioned, for example. The material which performed various surface treatment which contains other artificial graphite and purification natural graphites, such as a graphitization mesophase microsphere and a graphitization mesophase pitch based carbon fiber, in the artificial-graphite list manufactured by elevated-temperature heat treatment of the ***** pitch suitably obtained from various raw materials, and contains a pitch in these graphites is used.

[0023] As for d value (distance between-layers) of the lattice plane (002nd page) which asked for these carbonaceous objects by the X diffraction by the **** method, what is 0.335-0.34nm is desirable, and what is 0.335-0.337nm is more desirable. It is desirable that it is 1 or less % of the weight, as for ash content, it is more desirable that it is 0.5 or less % of the weight, and it is desirable that it is especially 0.1 or less % of the weight. Moreover, it is desirable that it is 30nm or more, as for the microcrystal size (Lc) for which it asked by the X diffraction by the **** method, it is more desirable that it is 50nm or more, and it is desirable that it is especially 100nm or more.

[0024] Moreover, it is more desirable that it is 3-50 micrometers or less, it is desirable that it is 1-100 micrometers, and it is as for the median size of the carbonaceous object by the method of laser diffracting / being scattered about, it is still more desirable that it is 5-40 micrometers, and] desirable [a median size] that it is especially 7-30 micrometers. It is more desirable that it is 0.5-20.0m²/g, it is desirable that they are 0.3-25.0m² / g, and it is [as for BET adsorption method specific surface area, it is still more desirable that they are 0.7-15.0m² / g, and] desirable that they are especially 0.8-10.0m² / g. moreover, the Raman spectrum analysis using Ar-ion-laser light -- setting -- intensity ratio R=IB of the peak PA of the range of 1580-1620cm⁻¹, and (peak intensity IA) the peak PB (peak intensity IB) of the range of 1350-1370cm⁻¹ / IA 0-1.2 are desirable and, as for especially the full width at half maximum of the range of 1580-1620cm⁻¹, it is [one or less / 26cm⁻¹ -] desirable that it is one or less [25cm⁻¹ -].

[0025] It can mix in these carbonaceous objects further, and the negative-electrode material which can emit [occlusion and] a lithium can also be used for them. As negative-electrode material which can emit [occlusion and] lithiums other than a carbonaceous object, metallic-oxide materials, such as tin oxide and oxidation silicon, and the lithium alloy of versatility [list / lithium metal] further can be illustrated. Two or more kinds may be mixed and these negative-electrode materials may be used. It is not limited especially about the method of manufacturing a negative electrode using these negative-electrode materials. For example, it can apply to the substrate of a charge collector, and by drying, a negative electrode can be manufactured and roll forming of this negative-electrode material is carried out as it is, and a binder, a thickener, electric conduction material, a solvent, etc. can be added to a negative-electrode material if needed, and it can consider as the shape of

a slurry, and can also consider [it can consider as a sheet electrode or] as a pellet electrode with compression molding. [0026] About the binder used for manufacture of an electrode, to the solvent or the electrolytic solution which are used at the time of electrode manufacture, if it is a stable material, it will not be limited especially. As the example, polyvinylidene fluoride, polytetrafluoroethylene, styrene-butadiene rubber, polyisoprene rubber, butadiene rubber, etc. can be mentioned. As a thickener, a carboxymethyl cellulose, methyl cellulose, a hydroxymethyl cellulose, ethyl cellulose, polyvinyl alcohol, oxidation starch, phosphorylation starch, casein, etc. are mentioned. As electric conduction material, carbon materials, such as metallic materials, such as copper and nickel, graphite, and carbon black, are mentioned. The quality of the material of the charge collector for negative electrodes has the point of metals, such as copper, nickel, and stainless steel, being used and being easy to process it into a thin film in these, and the point of cost to desirable copper foil.

[0027] As a material of the positive electrode which constitutes the cell of this invention, the material which emits [occlusion and] lithiums, such as lithium transition-metals multiple oxide materials, such as a lithium cobalt oxide, a lithium nickel oxide, and a lithium manganic acid ghost, can be used. Especially about the manufacture method of a positive electrode, it is not limited but can manufacture according to the manufacture method of the above-mentioned negative electrode. Moreover, about the configuration, after mixing, a binder, electric conduction material, a solvent, etc. can be added to a positive-electrode material if needed, and it applies to the substrate of a charge collector, and it can consider as a sheet electrode or can consider [press forming can be performed and] as a pellet electrode. As for the quality of the material of the charge collector for positive electrodes, metals, such as aluminum, titanium, and a tantalum, or the alloy of those is used. In these, since especially aluminum or its alloy is lightweight, it is desirable in respect of energy density.

[0028] It is not limited especially about the quality of the material or the configuration of a separator which are used for the cell of this invention. However, it is stable to the electrolytic solution, and choosing from the solution retention outstanding materials is desirable, and it is desirable to use a porous sheet or a nonwoven fabric etc. which uses polyolefines, such as polyethylene and polypropylene, as a raw material.

[0029] Especially about the method of manufacturing the cell of this invention which has a negative electrode, a positive electrode, and a nonaqueous electrolyte at least, it is not limited but can choose suitably from the methods usually adopted. Moreover, the coin type which carried out the laminating of the cylinder type, pellet electrode, and separator of the inside-out configuration which combined the cylinder type, pellet electrode, and separator which were not limited especially about the configuration of a cell but made the sheet electrode and the separator the shape of a spiral is usable.

[0030]

[Example] Although an example and the example of a comparison are given to below and this invention is explained to it still more concretely, this invention is not limited to these examples, unless the summary is exceeded.

(Example 1) The carbon black 6 weight section and the polyvinylidene fluoride KF-1000(Kureha chemistry company make, trade name) 9 weight section were added to the LiCoO₂ 85 weight section as positive active material, and it mixed, and distributed by the N-methyl-2-pyrrolidone, and what was made into the shape of a slurry was applied to homogeneity on aluminium foil with a thickness of 20 micrometers which is a positive-electrode charge collector, and after desiccation, it pierced to discoid with a diameter of 12.5mm, and considered as the positive electrode.

[0031] As a negative-electrode active material, d value of the lattice plane (002nd page) in an X diffraction should set 0.04% of the weight to the Raman spectrum [median size / according / accord / 0.336nm and crystallite size (Lc) / 100nm or more (264nm) / ash content / to the method of laser diffracting / being scattered about / specific surface area / 17 micrometers and / BET adsorption method] analysis using 8.9m² / g, and Ar-ion-laser light. The peak PA of the range of 1580-1620cm⁻¹ (Peak intensity IA) artificial-graphite powder KS-44 [and] (the TIMCAL, LTD. make --) whose full width at half maximum of the range of 0.15 and 1580-1620cm⁻¹ intensity ratio R=IB of the peak PB (peak intensity IB) of the range of 1350-1370cm⁻¹ / IA is 22.2cm⁻¹ The polyvinylidene fluoride 5 weight section was mixed in the trade name 95 weight section, and what was made to distribute by the N-methyl-2-pyrrolidone, and was made into the shape of a slurry was applied to homogeneity on copper foil with a thickness of 18 micrometers which is a negative-electrode charge collector, and after desiccation, it pierced to discoid with a diameter of 12.5mm, and considered as the negative electrode.

[0032] About the electrolytic solution, vinyl ethylene carbonate is dissolved in 97 % of the weight (1:1 volume ratios) of mixture of propylene carbonate and ethylene carbonate at 3% of the weight of a rate, using as a solute the 6 phosphorus-fluoride acid lithium (LiPF₆) which fully dried under the desiccation argon ambient atmosphere, and it is LiPF₆ further. It dissolved and prepared at a rate of one mol/l. The positive electrode was held in the can made from stainless steel which serves as a positive-electrode conductor using these positive electrodes, a negative electrode, and the electrolytic solution, and the negative electrode was laid through the separator made from polyethylene to which impregnation of the electrolytic solution was carried out on it. the obturation board which serves both as this can and a negative-electrode conductor -- the gasket for an insulation -- minding -- it sealed in total and the coin mold cell was produced.

[0033] (Example 1 of a comparison) To the mixture (1:1 capacity factors) of propylene carbonate and ethylene carbonate, it is LiPF₆. The coin mold cell was produced like the example 1 except having used the electrolytic solution dissolved and prepared at a rate of one mol/l.

* [0034] (Example 2) Vinyl ethylene carbonate was dissolved in 97 % of the weight (1:1 capacity factors) of mixture of ethylene carbonate and gamma-butyrolactone at 3% of the weight of a rate, and the coin mold cell was produced like the example 1 except having used the electrolytic solution which dissolved and prepared LiPF₆ at a rate of one mol/l. further.

[0035] (Example 2 of a comparison) To the mixture (1:1 capacity factors) of ethylene carbonate and gamma-butyrolactone, it is LiPF₆. The coin mold cell was produced like the example 1 except having used the electrolytic solution dissolved and

prepared at a rate of one mol/l.

[0036] (Example 3) Vinyl ethylene carbonate is dissolved in 97 % of the weight (1:1 capacity factors) of mixture of propylene carbonate and gamma-butyrolactone at 3% of the weight of a rate, and it is LiPF₆ further. The coin mold cell was produced like the example 1 except having used the electrolytic solution dissolved and prepared at a rate of one mol/l.

[0037] (Example 3 of a comparison) To the mixture (1:1 capacity factors) of propylene carbonate and gamma-butyrolactone, it is LiPF₆. The coin mold cell was produced like the example 1 except having used the electrolytic solution dissolved and prepared at a rate of one mol/l.

[0038] (Example 4) Vinyl ethylene carbonate is dissolved in 97 % of the weight of propylene carbonate at 3% of the weight of a rate, and it is LiPF₆ further. The coin mold cell was produced like the example 1 except having used the electrolytic solution dissolved and prepared at a rate of one mol/l.

[0039] (Example 4 of a comparison) It is LiPF₆ to propylene carbonate. The coin mold cell was produced like the example 1 except having used the electrolytic solution dissolved and prepared at a rate of one mol/l.

[0040] (Example 5) Vinyl ethylene carbonate is dissolved in 95 % of the weight (1:1 capacity factors) of mixture of propylene carbonate and ethylene carbonate at 5% of the weight of a rate, and it is ** LiPF₆. The coin mold cell was produced like the example 1 except having used the electrolytic solution dissolved and prepared at a rate of one mol/l. In 25 degrees C, charge termination voltage 4.2V were performed by 0.5mA constant current, and the charge and discharge test was performed for the cell produced in the above-mentioned examples 1-5 and the examples 1-4 of a comparison by discharge-final-voltage 2.5V.

[0041] The electrical conductivity in 20 degrees C of the electrolytic solution used for examples 1-5 and -30 degrees C is shown in a table 1. In addition, measurement of electrical conductivity was measured using the conductivity meter (the Toa Electronics, Ltd. make, CM-30S). The flash point is JIS. It measured based on K-2265. The discharge capacity and charge-and-discharge effectiveness of 1 cycle eye per negative-electrode weight in each cell are shown in a table 2. Here, charge-and-discharge effectiveness is searched for from the following formulas.

[0042]

[Equation 1] Charge-and-discharge effectiveness (%) = [(discharge capacity)/(charge capacity)] x 100 [0043] Disassembly of the electrolytic solution is intense and the examples 1, 3, and 4 of a comparison did not operate as a cell as shown in tables 1 and 2. On the other hand, without solidifying also in -30 degrees C, the electrolytic solution of this example has comparatively high conductivity, and the capacity at the time of considering as a cell and charge-and-discharge effectiveness are also excellent.

[0044]

[A table 1]

表 1

	電気伝導度 (mS/cm)		引火点 ℃
	20℃	-30℃	
実施例1	6.2	1.1	140
実施例2	9.1	2.6	119
実施例3	8.1	2.3	119
実施例4	5.3	1.0	138
実施例5	6.1	1.0	140

[0045]

[A table 2]

表 2

	1サイクル目容量 mAh/g	1サイクル目効率 %
実施例 1	226	81.3
実施例 2	230	83.0
実施例 3	213	81.1
実施例 4	198	78.1
実施例 5	233	84.4
比較例 1	—	—
比較例 2	120	34.4
比較例 3	—	—
比較例 4	—	—

[0046]

[Effect of the Invention] Since one sort or two sorts or more of solvents with which specific inductive capacity is chosen from 25 or more solvents are contained 90% of the weight or more and the flash point uses a non-aqueous solvent 70 degrees C or more, the nonaqueous electrolyte rechargeable battery of this invention has high safety, and its charge-and-discharge effectiveness is high, and it is excellent in a cycle property. Furthermore, it can make it possible to produce a rechargeable battery with good cycle property and conservation property under an elevated temperature.

[Translation done.]